

Unit Topic: Matter

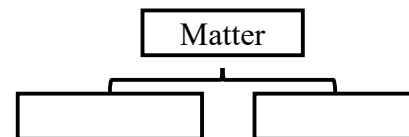
Essential Question: How do atomic and molecular interactions explain the properties of matter we see and feel?

<u>Concept 1:</u> <i>Classification of Matter</i>	<u>Concept 2:</u> <i>Properties of Matter</i>	<u>Concept 3:</u> <i>States of Matter</i>
<u>Objectives:</u> <i>Classify matter based on a picture, description, or real-world example.</i> <u>Vocabulary:</u> Matter Substance Mixture Element Compound <u>Practice:</u> - Differentiate between a homogeneous mixture and a heterogeneous mixture. - Explain the main difference between a compound and a mixture. - Draw a flow chart to represent how matter can be classified. - Classify each example below as the type of matter it is (element, compound, homogeneous mixture or heterogeneous mixture). - Table salt - Milk - Oxygen - Lemonade - Water - Carbon dioxide - Vegetable soup - Peanut butter	<u>Objectives:</u> <i>Given a scenario or description, classify a property or change as chemical or physical.</i> <i>Calculate volume and density for regular and irregularly shaped objects.</i> <u>Vocabulary:</u> Melting point Boiling point Viscosity Solubility Solute Solvent Solution Density Combustibility Reactivity Oxidation Chemical reaction Law of conservation of matter <u>Practice:</u> - Explain the difference between physical properties and chemical properties, and list three examples of each. - Explain the difference between physical changes and chemical changes. - A piece of metal is 4 cm by 10 cm by 2 cm. Find its mass if it has a density of 2 g/cm³. - A piece of plastic with a mass of 15 g is placed in a graduated cylinder. The water level in the graduated cylinder rises from 30 mL to 55 mL when the plastic is added. Find the density of the plastic. - Classify the following changes as physical or chemical. - Boiling - Crumpling - Burning - Freezing - Evaporating - Rotting - Rusting - Sawing - Crushing - List evidence that a chemical change, and thus a chemical reaction, has occurred.	<u>Objectives:</u> <i>Given a description or picture, determine the state of matter.</i> <i>Analyze and interpret a heating curve graph.</i> <u>Vocabulary:</u> Temperature Plasma Bose-Einstein condensates Heat of fusion Heat of vaporization Vaporization Evaporation Boiling <u>Practice:</u> - List the three principles of the kinetic molecular theory. - Explain the difference between solids, liquids, and gases. Include volume, shape, and particle motion in your description. - List real-world examples of where plasma can be found and what Bose-Einstein condensates are used for. - Is state change physical or chemical? Explain how you know. - Draw the changing states of matter diagram. - Sketch a sample heating curve and label melting point, boiling point, heat of fusion, heat of vaporization, solid, liquid and gas.

Concept 1 Notes: Classification of Matter

Matter = anything that takes up _____
and has _____

- *Matter is either a substance or a mixture*



Substance - all _____ in matter are _____ (fixed composition)

Element - _____ form of matter
from which more complex substances
_____ (listed on the Periodic Table)

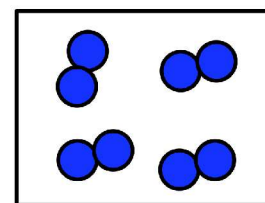
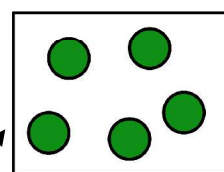
- All the _____ that make up an
element are _____

- Ex. _____

- Elements can exist as:

- Monatomic: Elements like Helium,
Argon, and Neon that are stable as an

- Diatomic: Elements like Oxygen, Nitrogen and Hydrogen that are
stable as _____ of themselves bonded together (O_2 ,
 N_2 , H_2)

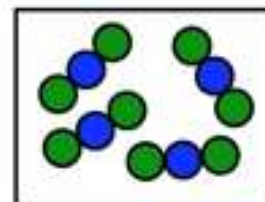


Compound - two or more elements
_____ in a fixed
proportion

- Can be _____, but only
by chemical reactions

- Have properties different than the
_____ that make them up

- Ex. _____ (water), NaCl (table salt),
_____ (sugar)



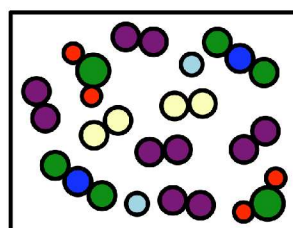
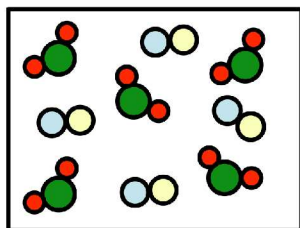
Mixture - _____ substances physically _____
(variable composition)

Homogeneous: components are
_____ distributed out
on a microscopic level

- _____ (when one substance is dissolved into another) are homogenous mixtures
- Usually appears
“ _____ ”
- Ex. Bleach, _____, coffee

Heterogeneous: substances in the mixture are _____
spread out

- Different components are easy to see, or _____ over time
- Ex. Salad dressing, _____, cereal



Summary Concept 1

Draw the classifying matter flow chart.

Practice: Classification

Part 1: Classify the following as a substance (S) or a mixture (M).

- | | | |
|----------------------------|--------------------|-------------------|
| _____ 1. Table salt (NaCl) | _____ 2. Trail mix | _____ 3. Sugar |
| _____ 4. Copper | _____ 5. Cereal | _____ 6. Concrete |

Part 2: Classify the following substances as elements (E) or compounds (C).

- | | | |
|------------------|--------------------|------------------------------------|
| _____ 7. Mercury | _____ 8. Water | _____ 9. Carbon dioxide |
| _____ 10. Iron | _____ 11. Aluminum | _____ 12. Oxygen (O ₂) |

Part 3: Classify the following mixtures as homogeneous (HO) or heterogeneous (HE).

- | | | |
|---------------------|------------------|----------------|
| _____ 13. Coffee | _____ 14. Pizza | _____ 15. Sand |
| _____ 16. Saltwater | _____ 17. Bronze | _____ 18. Milk |
| _____ 19. Paint | _____ 20. Air | _____ 21. Soil |

Part 4: Classify the following as an element (E), compound (C), homogeneous mixture (HO) or heterogeneous mixture (HE).

- | | | |
|---|--|--|
| _____ 22. Calcium | _____ 23. Hydrogen (H ₂) | _____ 24. Orange juice with pulp |
| _____ 25. Baking soda (NaHCO ₃) | _____ 26. Helium | _____ 27. Limestone (CaCO ₃) |
| _____ 28. Salad dressing | _____ 29. Vinegar (CH ₃ COOH) | |

Part 5: Each of the following circles represents an atom. If two atoms are touching then they are bonded together. Knowing this, classify each picture as one of the following:

A – Element

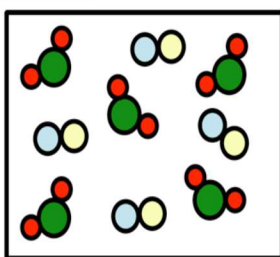
B = Compound

C = Mixture of elements

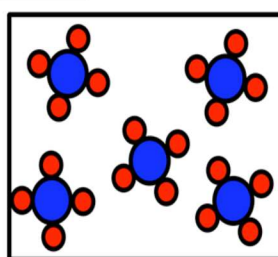
D = Mixture of compounds

E = Mixture of elements and compounds

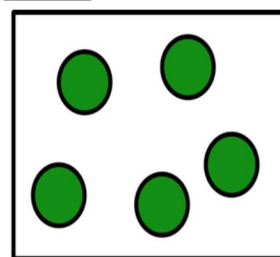
30. _____



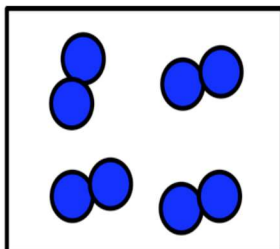
31. _____



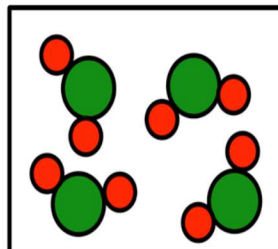
32. _____



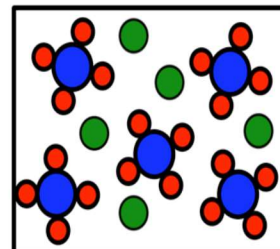
33. _____



34. _____



35. _____



Lab Stations: Classification and Properties of Matter

Answer the questions from each station in the boxes below. You must clean up the station before moving on to the next. It should look EXACTLY like it did when you got to it.

Station 1

CLASSIFYING

Station 2

MATTER DETECTIVE

Station 3

LIQUID LAYERS

Station 4

MARBLE RACE

Station 5

MYSTERY OF THE DISAPPEARING MATERIALS

Station 6

CHANGE IT UP

Concept 2 Notes: Properties of Matter

Physical Properties: properties that can be observed _____ or measured without changing the _____ of the substance

- Ex. Mass, _____, shape, size, _____, luster, hardness, etc.

Melting point: temperature at which a _____ becomes a _____

Boiling point: temperature at which a _____ becomes a _____

Viscosity: a fluid's _____ to _____

- A physical property only of _____
- Can change with _____
- Think “*how _____ it is*”
- Ex. Viscosity of syrup is high and of water is low

Solubility: a measure of how well a solute _____ in a solvent

Solute = what is _____ (Ex. *Lemonade powder*)

Solvent = what is _____ (Ex. *Water*)

Solution = the _____ (Ex. *Lemonade*)

Density: measure of _____ or consistency of a material

- _____ per unit of _____
- Measured in _____ or _____
- Density doesn't change, regardless of _____
- Mass is measured in _____ (g), using a _____
- Volume is measured in _____ or _____, using 2 different methods

Density =

Finding volume to calculate density

1. Volume of a solid: if a _____ shape, use a ruler and the appropriate _____ equation
 - *Cube or rectangle prism:* $V =$ _____
 - *Cylinder:* $V =$ _____
 - Measured in _____

Example #1: *What is the density of a 15 g box measuring 10 cm by 5 cm by 2 cm?*

2. Volume of a liquid: if a _____ or an irregularly shaped solid, use a _____ (and water displacement for a solid)
 - Measured in _____
 - Water Displacement:
 1. Put enough water in graduated cylinder to cover the object
 2. Record initial volume
 3. Add object
 4. Record final volume, with object in it
 5. Subtract $v_f - v_i$ to find the volume of the object

Example #2: *A sample of aluminum is put into 10.5 mL of water. If the water rises to 13.5 mL when the aluminum is added, what is the density of the aluminum if it has a mass of 8.1 g?*

Chemical Properties: properties that can only be _____ or measured by changing the _____ of a substance

- By observing it a _____ is formed
- Ex. Toxicity, _____, combustibility, _____, etc.

Combustibility: how easily a substance will _____

- *Ex. Burning charcoal*

Reactivity: how easily a substance _____, usually with an _____

- *Ex. Fluorine gas is highly reactive and will spontaneously ignite a concrete block at room temperature*

Oxidation: how easily a substance reacts with _____

- *Ex. Iron reacts with oxygen and moisture to create rust*

Physical Change: a change in a substance that only affects its _____

- *Ex. Cutting, coloring, crushing, melting, boiling, etc.*

Chemical Change: a change in a substance that affects its _____ properties thus a _____ occurs and a new substance is formed

- *Ex. Burning, rusting, decomposing, etc.*

Chemical Reaction: process by which the _____ of one or more substances are _____ to form _____ substances

Law of Conservation of Matter

- Matter is neither _____ or _____ during a chemical change. It only changes _____.
- *Mass cannot be “_____”, even when a chemical reaction happens.*

Evidence of a Chemical Change

- Signs that a chemical change has occurred, resulting in a chemical reaction include:
 - Release of _____
 - _____ change
 - _____ change
 - Sudden _____ change
 - _____ given off
 - Sudden appearance of a _____ (called a *precipitate*)

Summary Concept 2

Compare and contrast chemical vs. physical changes, as well as chemical vs. physical properties.

Practice: Density Calculations

Answer the following questions. Make sure to show all work to receive credit. You may need a separate sheet of paper.

1. Find the volume of a box measuring 2 cm by 7 cm by 3 cm.
2. An object placed in a graduated cylinder raises the volume from 12.2 mL to 14.5 mL. Find the volume of the object.
3. Find the volume of a cube measuring 5 cm on each side.
4. Find the density of the box in #1 if it has a mass of 20 g.
5. Find the density of the object in #2 if it has a mass of 4 g.
6. Find the density of the cube in #3 if it has a mass of 100 g.
7. Find the mass of an object that has a density of 1.5 g/cm^3 and has a volume of 8 cm^3 .
8. Find the volume of an object with a density of 3.1 g/mL and a mass of 12 g.
9. Find the mass of a cube that has a density of 2.7 g/mL and measures 3 cm on each side.
10. **Challenge:** Find the density of a soda can with a radius of 3.25 cm, a height of 12.2 cm, and a mass of 40 g.

Lab Activity: Mystery Material Identification

Guiding Question: How can physical properties, like density, be used to identify unknown substances?

Purpose: To determine the identity of unknown substances, using physical properties such as density.

Introduction: Density is a physical property of matter that measures the compactness of a substance. Common materials have known densities, so they can be used to identify the identity of unknown materials. In this lab activity, you will be using your skills to find the mass and volume of each unknown substance so that you can calculate the density of it and determine its identity.

Hypothesis: *As you acquire each object, make a prediction as to what material you think it is before making ANY measurements. Record in your data table.*

Materials:

- Set of unknown objects
- Digital scale
- Ruler
- Graduated cylinder

Procedure:

1. Retrieve one object from the set. Locate what number it is. Make observations of the object. Write your prediction as to what you believe it is made out of in your data table. Make sure to write it in the correct row based on what number it is.
2. Record the color of the object in the next column.
3. Find the mass using the digital scale. Record in data table.
4. Find the volume. You may use the water displacement method or the appropriate geometric equation. Record in data table.
5. Calculate the density of the object and record in data table. Use this density and the reference table below to determine its identity. Record in data table.
6. Repeat steps #1-5 for each object.

Reference Table

Density of Common Materials

Density (g/cm ³)	Substance	Density (g/cm ³)	Substance
0.24	Cork	1.37	Polyvinyl chloride (PVC)
0.43	Pine	1.42	Acetyl
0.59	Walnut	1.56	Chlorinated PVC (CPVC)
0.70	Oak	1.74	Magnesium
0.75	Maple	2.20	PTFE (Teflon)
0.91	Polypropylene	2.70	Aluminum
0.94	Polyethylene (LDPE)	4.51	Titanium
1.05	Polystyrene	7.80	Steel
1.15	Polyamide (Nylon)	8.73	Brass
1.17	Acrylic	8.96	Copper
1.23	Polyurethane	11.3	Lead
1.32	Phenolic	19.3	Gold

Results

	Prediction	Color	Mass (g)	Volume (cm ³ or mL)	Density (g/cm ³)	Actual Substance
1						
2						
3						
4						
5						
6						
7						
8						
9						
10						
11						
12						
13						
14						
15						

Analysis

1. Refer back to your predictions you made for each material. How many matched the substance's identity you determined from the density? How could you have made more accurate predictions?
2. How confident are you in your identifications? Explain.
3. In what ways is the lab useful for identifying unknown substances?
4. In what ways is the lab not useful for identifying unknown substances? What are its limitations?
5. Which format did you prefer for finding volume? Which do you think is most likely more accurate? Explain why.
6. Explain one way that this knowledge could be helpful in the real world.

Lab: Conservation of Matter

Introduction: Matter can undergo physical and chemical changes. In a chemical change, a chemical reaction occurs and a new substance is formed. According to the law of conservation of matter, matter cannot be created or destroyed, even in a chemical reaction. Can scientific laws such as this be violated? In this lab you will explore physical and chemical changes as well as the validity of the law of conservation of matter while popping popcorn kernels.

*You will be writing out this lab as we go to practice applying the scientific method to writing a formal lab report. Helpful hints are embedded in italicizes below each section to help you. **Overall, scientific writing is done in the 3rd person. So don't include I, you, us or we!***

Guiding Question

What over-arching question are we trying to answer?

Purpose

Make a clear statement about what we are trying to determine.

Hypothesis

Come up with a specific testable prediction for what you think will happen. It does NOT need to be the same as the whole class and it DOESN'T matter if you end up being "wrong." Make sure to write it as an "If...then..." statement.

Materials

List the specific materials we are using (include brands if applicable) below. You may not need every bullet, and you may need to add more.

- | | |
|---|---|
| • | • |
| • | • |
| • | • |
| • | • |
| • | • |
| • | • |

Procedure

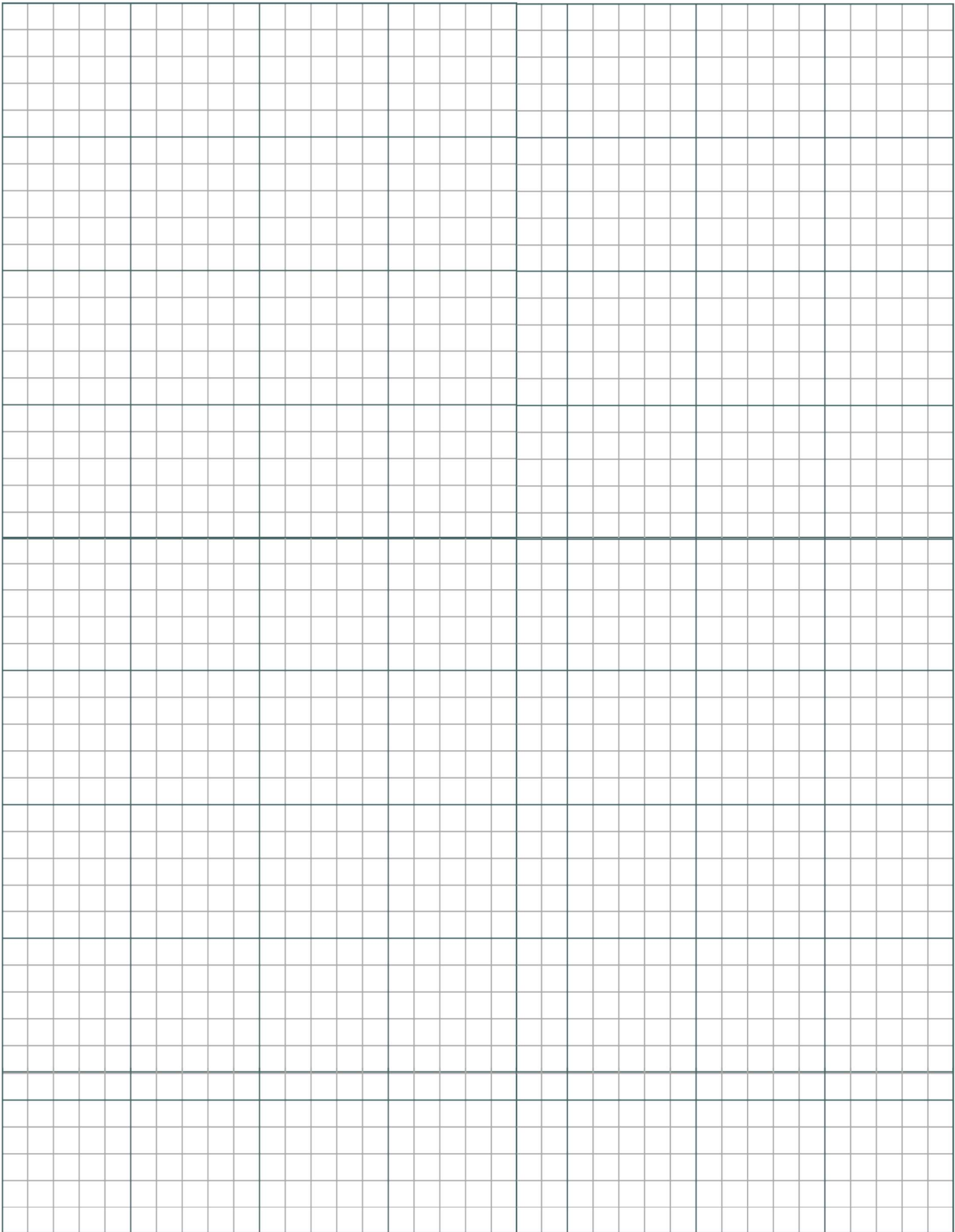
*Create a **numbered** list of steps below. Include enough detail to replicate this lab, but assume the reader is your age so they don't need to know that they need to "gather all materials," and other things like this. Good procedures start each step with a verb (action-word) and are written as commands. Use the lines on the next page also, as needed.*

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Results

Use a ruler to create two data tables below. One data table should have the specific data that your group collects. The second data table should be a collection of the class data we will gather once everyone has submitted their numbers. Each data table needs a descriptive title.

On the next page, use a ruler to create a graph on the graph paper. Make sure to include a title, appropriate axis labels, and a key, if necessary. Think: what type of graph would be most appropriate for this data?



Analysis

This is the first part of the write-up that needs to be written in paragraph form. A good analysis tends to have at least 3 well-written paragraphs. The following topics need to be addressed:

- Experimental set-up: Do NOT re-write the procedures, but do explain what we were testing (independent variable), what we were measuring (dependent variable), our control group, experimental group, and constants.
- Refer to your graph and explain what it shows you. Did the mass differ before and after popping? Provide reasoning for why it did or did not.
- Error analysis: Write out at least three ways your data may not be completely accurate. Include a specific solution to prevent each error in the future.

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Practice: Physical vs. Chemical

Part 1: *Classify the following properties as physical (P) or chemical (C).*

1. Density
2. Flammability
3. Boiling point
4. Hardness
5. Odor
6. Taste
7. Ability to neutralize a base
8. Luster
9. Ability to react with water
10. Combustibility

Part 2: *Classify the following changes as physical (P) or chemical (C).*

11. Milk souring.
12. Sodium chloride dissolving in water.
13. Water heating and changing into steam.
14. Iron rusting.
15. Wood rotting.
16. Sugar added to sweet tea.
17. A bike tire being inflated with air.
18. Window glass shattering.
19. A paper towel absorbing spilled water.
20. Mowing the lawn.

Part 3: *Write below what criteria you use to determine if something is physical or chemical.*

Lab Activity: States of Matter

Guiding Question: How does state change relate to temperature?

Purpose: To determine the relationship between state change and temperature through the creation of a heating curve.

Introduction: The law of conservation of energy (also known as the 1st law of thermodynamics) states that energy can never be created or destroyed, it only changes forms. Substances can change form (or state) by absorbing or releasing energy. Water is a substance you've most likely seen in all of its different forms: solid, liquid and gas. Today you are going to observe solid water as it absorbs energy and changes states.

Hypothesis: *Temperature is the average kinetic energy of all particles in an object. Considering this, make a prediction about what you believe will happen to the energy of the particles and the water's state of matter as its temperature increases.*

Materials:

- Ice
- 500 mL beaker
- Hot plate
- Beaker tongs
- Thermometer
- Stopwatch
- Safety goggles

Procedure:

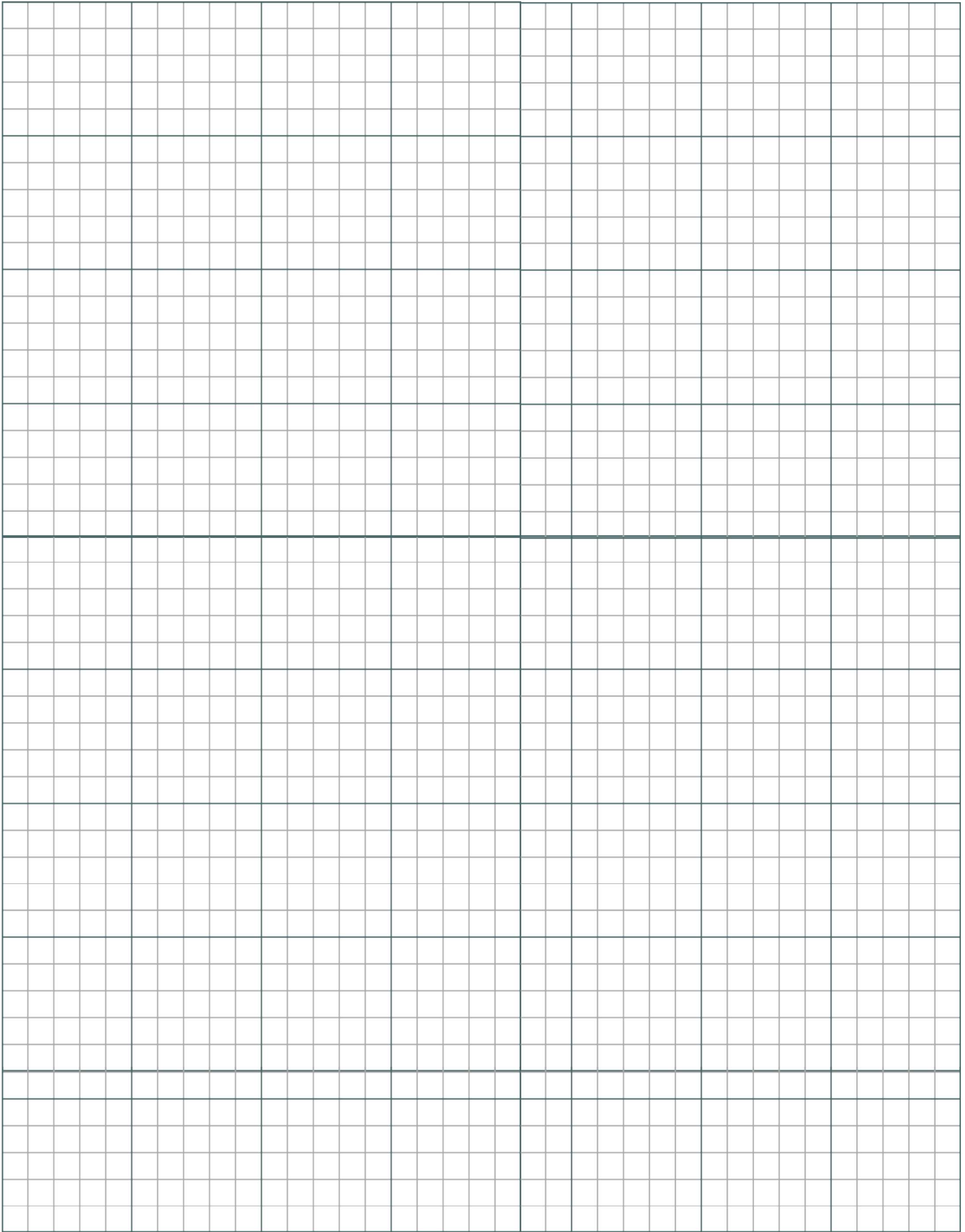
1. Fill the beaker halfway full with ice.
2. Place the beaker on the hot plate. Use the thermometer to measure the initial temperature of the ice in degrees Celsius. Record in Data Table 1.
3. Plug in the hot plate and turn on medium-high heat. Start the stopwatch as soon as you turn on the hot plate. One partner should regularly check the temperature on the thermometer while the other partner keeps track of the time. If for some reason you need to move the beaker, use the tongs.
4. Every 30 seconds, record the temperature in Data Table 1.
5. Set up Data Table 2 next to Data Table 1. In it, record the time (or time frame) and temperature for which you observe the following key events:
 - a. Only solid water in the beaker.
 - b. Liquid water first appears in the beaker.
 - c. Only liquid exists in the beaker.
 - d. Gaseous water first appears in the beaker.
 - e. Water begins boiling strongly throughout.
6. Continue taking temperature readings until the water boils for 4 minutes straight. Then turn off and unplug the hot plate. Remove beaker from heat and let cool before dumping out the contents.
7. Create a line graph of temperature vs. time (called a **heating curve**).

Results

Data Table 1: Temperature Change over Time

Time (min)	Temperature (°C)	Time (min)	Temperature (°C)
0		15.5	
0.5		16	
1		16.5	
1.5		17	
2		17.5	
2.5		18	
3		18.5	
3.5		19	
4		19.5	
4.5		20	
5		20.5	
5.5		21	
6		21.5	
6.5		22	
7		22.5	
7.5		23	
8		23.5	
8.5		24	
9		24.5	
9.5		25	
10		25.5	
10.5		26	
11		26.5	
11.5		27	
12		27.5	
12.5		28	
13		28.5	
13.5		29	
14		29.5	
14.5		30	
15		30.5	

Data Table 2: Key Events



Analysis:

1. Refer to your graph. As time went on, what was happening to the temperature of the water?
2. At what temperature did you first see liquid forming?
3. Think back to Concept 2 when we learned about physical properties. What is the temperature you listed in #2 called?
4. At what temperature did you first see steam forming?
5. Think back to Concept 2 when we learned about physical properties. What is the temperature you listed in #4 called?
6. Refer back to your observations in Data Table 2. Label those key events on your graph. Which state of matter did the water stay the longest in?
7. Was your hypothesis supported or rejected by your data? Explain.
8. Refer back to the definition of temperature and reflect on what you observed in this lab. Describe what is happening to the particles in the water as the temperature increases.

Concept 3 Notes: States of Matter

Energy Review

- Thermal energy: the sum of the _____ and _____ energy of particles in an _____
- Kinetic energy: energy in _____
- Potential energy: _____ energy
- *This relates to matter – specifically how matter physically changes _____ due to the _____ of the particles within it*
- *A theory explains what we know to be true about this*

Kinetic Molecular Theory

1. All matter is made of _____ particles. (*atoms, ions, molecules, etc.*)
2. Those particles are in _____ motion.
3. This motion causes the particles to _____ with each other and the _____ that they are in.

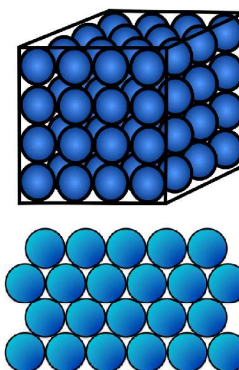
Temperature: measure of the average _____ of particles in an object

- The higher the _____, the higher the _____, the greater the _____ of the particles
 - *How does this connect to states of matter like solids, liquids, and gases?*
 - *How do you think the motion of the particles differs in each state?*

3 Main States of Matter

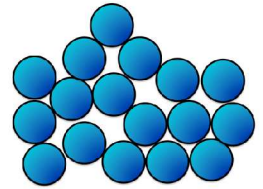
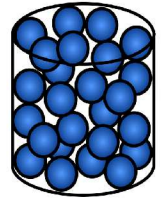
Solid

- Fixed _____ and fixed _____
- Particles are held _____ together in a _____ structure
- Particles have _____ kinetic energy
- Because of this, particle motion is limited to _____



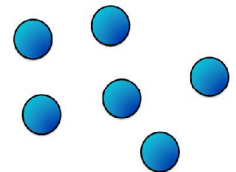
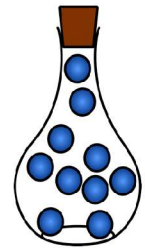
Liquid

- Fixed _____ but shape _____ based on container it is in
- Particles have _____ kinetic energy than _____
- Particles can _____ or slide past each other



Gas

- No fixed volume or _____
- If confined, gas particles will _____ to fill the container
- Called _____
- Particles have _____ kinetic energy
- _____ is high enough to overcome any _____ that hold the particles together
- Particles can _____ move



2 other States of Matter

Plasma: matter composed of _____ and _____ charged particles with extremely _____ kinetic energy

- Most _____ form of matter in the universe
- Makes up _____, neon lights, _____

Bose-Einstein condensates: atoms that are _____ to such a _____ temperature (almost absolute zero) that they form a “super atom”

- *Created by scientists in _____*
- *All particles in the super atom are at the same _____ state*
- *Will even slow down _____ that passes through*
- Used to stimulate conditions in a _____

Changing States

- When particles gain or lose _____, they can undergo a _____ change

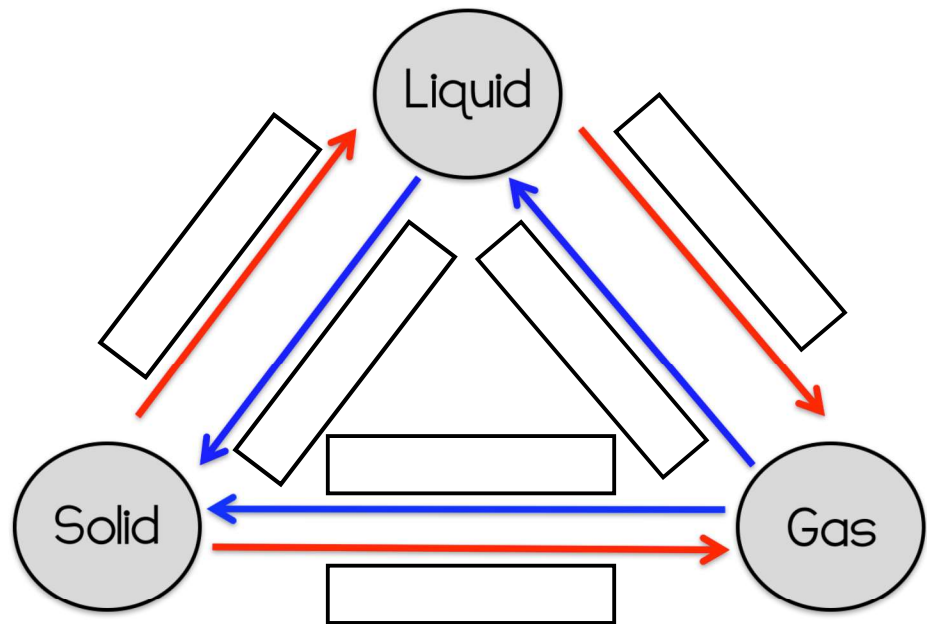
- This is a _____ change because the identity of the matter is still the same

- *Ex. When ice melts it is still water (H_2O)*

Heat of fusion: the amount of energy needed to turn a _____ into a _____ at its _____ point

- *When heat is added to a solid, it has more kinetic energy so that the particles vibrate faster and start moving farther apart as they transition to the liquid state*

Heat of vaporization: the amount of _____ needed to turn a _____ into a _____ at its _____ point



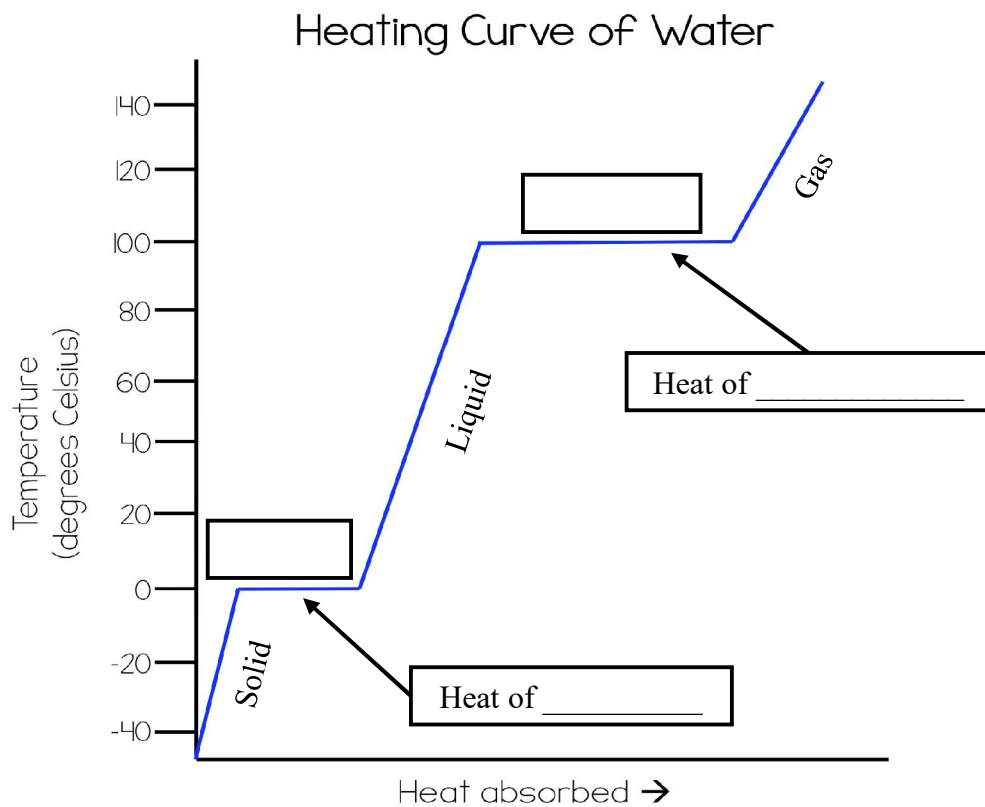
Vaporization: the phase/state transition from _____ to _____

- *Occurs two different ways...*

Evaporation: caused by _____ change, occurs only at the surface of a _____

Boiling: caused by a _____ change, occurs throughout the _____

Heating Curve: a diagram that shows the _____ a substance goes through as heat/energy is _____ to it



Summary Concept 3

Provide reasoning for why state change is physical and not chemical.

Practice: States of Matter

Answer the following questions. You may need a separate sheet of paper.

1. List the three principles of the kinetic molecular theory.
2. Consider the particles that make up solids, liquids, and gases. How would you describe how they are moving in each of these states of matter?
3. Describe the movement of particles at the melting point of a substance. Consider what is happening with temperature and energy.
4. Describe the movement of the particles at the boiling point of a substance. Consider what is happening with temperature and energy.
5. Acetic acid has a melting point of 16.6°C and a boiling point of 117.9°C . Sketch a heating curve showing the phase changes of acetic acid. Clearly label all 7 parts like we did in our notes.